

Appl. No. 10/822,648
Amendment dated: July 27, 2006
Reply to OA of: April 28, 2006

This listing of claims will replace all prior versions and listings of claims in the application.

Listing of Claims:

1(currently amended). A substrate with a vertical zinc oxide nanowire array comprising:

a substrate;

a crystal phase adjusting buffer on a surface of the substrate, wherein the crystal phase adjusting buffer is a single or multiple layer film made of oxide or nitride; and

a nanowire compound layer;

wherein the nanowire compound layer comprises a zinc oxide layer on the crystal phase adjusting buffer, a vertical zinc oxide nanowire array on the zinc oxide layer, and zinc oxide nanowires of said array have diameters of 15-500 nm and aspect ratios of 3-300.

2(original). The substrate as claimed in claim 1 wherein the substrate is a single crystal, polycrystal or amorphous substrate with micrometer or nano-sized pores, or an irregular surface structure.

3(original). The substrate as claimed in claim 2 wherein the substrate is sapphire, magnesia, lithium niobate, strontium titanate, barium titanate, aluminum oxide, quartz, zirconia, glass or a silicon wafer.

Claim 4(canceled).

5(original). The substrate as claimed in claim 1 wherein the substrate is a silicon wafer, the crystal phase adjusting buffer comprises a silicon dioxide layer on said silicon wafer, a silicon nitride layer on said silicon dioxide layer and a doped zinc oxide layer on said silicon nitride layer, with respective thicknesses of 0.01-1 micrometers, 0.01-1

micrometers and 0.01-10 micrometers.

6(original). The substrate as claimed in claim 5 wherein the doped zinc oxide layer in the crystal phase adjusting buffer comprises a doping element selected from the group consisting of Al, Ga, Si, Ge, B, Ti, Sn, Mg, In, Cr, P and Zn.

7(original). The substrate as claimed in claim 1 wherein the substrate is a sapphire substrate, and the crystal phase adjusting buffer is a gallium nitride epitaxial layer with a thickness of 0.01-10 micrometers.

8(original). The substrate as claimed in claim 1 wherein the zinc oxide layer of the nanowire compound layer has a thickness of 0.2-12 micrometers.

9(original). A method for forming an array of zinc oxide nanowires on a substrate comprising:

a) forming a crystal phase adjusting buffer on the surface of the substrate; and
b) growing 1D zinc oxide nanowires on the crystal phase adjusting buffer, which comprises:

b1) generating a zinc vapor in a first vacuum chamber and exposing the substrate with the crystal phase adjusting buffer to the zinc vapor to grow a zinc oxide layer on the crystal phase adjusting buffer; and b2) generating another zinc vapor in a second vacuum chamber and exposing the substrate with the zinc oxide layer to the zinc vapor to form vertical zinc oxide nanowires on the zinc oxide layer, the zinc oxide nanowires having diameters of 15-500 nm and aspect ratios between 3-300.

10(original). The method as claimed in claim 9 wherein step b1) process conditions include: a vacuum value of the first vacuum chamber being 1-300 Torr; a heating temperature for generating the zinc vapor in the first vacuum chamber being 400°C~550°C; argon gas at 50-200 sccm flowing through the first vacuum chamber

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having 0.1-5% by volume of moisture or oxygen; and a reaction time between 1~60 minutes; wherein the substrate is placed at a downstream position in the argon gas flow, relative to where the zinc vapor is generated, and with a temperature difference from the heating temperature by -80~100°C.

11(original). The method as claimed in claim 9 wherein step b2) process conditions include: a vacuum value of the second vacuum chamber is 1-300 Torr; a heating temperature for generating the zinc vapor in the second vacuum chamber being 480°C~600°C; argon gas at 20-100 sccm flowing through the second vacuum chamber having 1-20% by volume of moisture or oxygen; and a reaction time between 10~120 minutes; wherein the substrate is placed at a downstream position in the argon gas flow, relative to where the zinc vapor is generated, and with a temperature difference from the heating temperature by -80~100°C.

12(original). The method as claimed in claim 9 wherein in both steps b1) and b2) the zinc vapor is generated by heating metal zinc in the form of powder, wire or block; or by heating zinc oxide powder in a reduction atmosphere.

13(original). The method as claimed in claim 9 wherein in both steps b1) and b2) the zinc vapor is generated by heating diethylzinc gas, solid of zinc acetyl acetonate salt which can be sublimated, zinc acetate, zinc 2-ethyl-hexanoate or zinc alkoxide salts.

14(original). The method as claimed in claim 9 wherein in both steps b1) and b2) the first vacuum chamber and the second vacuum chamber are the same vacuum chamber.

15(original). The method as claimed in claim 9 wherein the substrate is a single crystal, polycrystal or amorphous substrate with micrometer or nano-sized pores, or an irregular surface structure.

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16(original). The method as claimed in claim 15 wherein the substrate is sapphire, magnesia, lithium niobate, strontium titanate, barium titanate, aluminum oxide, quartz, zirconia, glass or a silicon wafer.

17(original). The method as claimed in claim 9 wherein the crystal phase adjusting buffer is a single or multiple layer film made of metal, oxide or nitride.

18(original). The method as claimed in claim 9 wherein the substrate is a silicon wafer, the crystal phase adjusting buffer comprises a silicon dioxide layer, a silicon nitride layer and a doped zinc oxide layer, with respective thicknesses of 0.01-1 micrometers, 0.01-1 micrometers and 0.01-10 micrometers.

19(original). The method as claimed in claim 18 wherein the doped zinc oxide layer in the crystal phase adjusting buffer comprises a doping element selected from the group consisting of Al, Ga, Si, Ge, B, Ti, Sn, Mg, In, Cr, P and Zn.

20(original). The method as claimed in claim 9 wherein the substrate is a sapphire substrate, and the crystal phase adjusting buffer is a gallium nitride epitaxial layer with a thickness of 0.01-10 micrometers.

21(original). The method as claimed in claim 9, wherein the zinc oxide layer of the nanowire compound layer has a thickness of 0.2-12 micrometers.